Address by

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Thank you. It is a pleasure to be with you this evening. The scope of the subject matter considered by the forums at this conference is most impressive. It is difficult to think of questions more significant for American industry than the future of nuclear power, air pollution and the relationship between coal and the utility market.

It is interesting to observe how many things we have in common. Both you in the power industry and we in the space program are closely watching the development of nuclear power. We are both paying careful attention to the tradeoffs between the cost and performance of nuclear energy and the cost and performance of energy supplied by chemical combustion. Your interest is in converting this energy to large-scale electrical power for the consumer; ours is in converting it to rocket thrust, or to the lightweight, highly efficient powerplant needed when men travel beyond the earth. But we are dealing with the same evolving technology.

Another interest we share is that in the fuel cell. As you know, this device had its origins in the 19th Century. But it was never really taken seriously by industry until the space program inspired a good deal of effort to make it usable, particularly in the Gemini and Apollo manned spacecraft. I understand that the challenge of the fuel cell is leading to some real soul searching in your industry. This illustrates well how technology associated with a major national program can find its way rather rapidly into the private sector of the economy.

A third area of mutual interest is the operation of electrical switches in a vacuum. Our Lewis Research Center in Cleveland has sponsored basic research in vacuum switching. Following the power failure in the Northeast in November 1965, NASA asked the Westinghouse Research and Development Center to prepare a survey of vacuum switching and its potential for improving reliability. This report has now been published. A few copies are available here at the conference.

Tonight I have been asked to talk about the manned space flight program and its progress and prospects. Really, I would like to leave just four thoughts with you. They are:

Why we have a space program.

What has been accomplished.

How much we are investing and the returns to date.

What we must do now to continue the return of these dividends.

First, then, why a space program? For perspective in answering this question, it is useful to go back to a statement issued nine years ago by President Eisenhower.

This statement expressed the thinking that underlay the National Aeronautics and Space Act of 1958, which began the space program and established the space agency.

President Eisenhower listed four reasons for space activity. They were as Follows:

-- The compelling urge of man to explore and to discover.

-- The wish to be sure that space is not used to endanger our national security.

-- The enhancement of United States prestige among the peoples of the world, and

-- The opportunities it affords to add to knowledge.

These were the reasons in the minds of our national leaders when they made the decision to get this program under way. They guided NASA in establishing program objectives.

These reasons are just as valid today as when they were stated. But in addition, the experience of the last nine years has produced additional reasons. These additional reasons underline the wisdom of our present course of action. Several are particularly worthy of note.

First, we have found that achievements in space give examples of what American free enterprise can produce for potential customers on the world market. They do what the advertising budget does for an individual business.

Second, the rapid progress of technology resulting from space research stimulates innovation and growth in our economy. I will discuss this further in a few minutes.

Third, space flight applications have provided and will provide new benefits to man on earth.

Fourth, to satisfy the requirements of the space program we have assembled a nationwide industry-university-government team with great skills and capabilities. The expense of accomplishing this was great. To obtain a return from the investment we must utilize that team.

Finally, by doing in space today those things that a few years ago were thought to be almost impossible, we stimulate confidence that we can solve difficult problems here on earth. Space flight helps the public to understand the great and growing ability of our industry, science and government to work together. Because of this public understanding, we now see new and imaginative efforts underway to mobilize our nation's resources to clean up our air and water, make cities more livable, improve transportation, and grow enough food for a hungry world.

But it is well to keep in mind the original stimulus of our space program. That stimulus was competition - the competition of the Soviet Union. This was evidenced especially by the Sputniks, the first probes of the moon, and the first men in space. But it should be noted that this competition is not just a race to be "first" in some specific achievement. It is a competition to be in the forefront of the world's technology industry. In recent years, achievements in our space program have improved the United States position in that competition. But the competition still persists.

Next, what is the status of the United States program? What are the principal achievements?

We have come a long way in the nine years since Congress passed the Space Act.

In those days our rockets often exploded on the launch pads. Today such an event is rare indeed.

In those days our satellites were the size of grapefruit and weighed as little as six pounds. Today, we can orbit spacecraft as large as the biggest tractor-trailers on the highways, weighing 20 tons or more.

In those days, we wondered whether failures in space foretold a decline in our country's position in the world. Today we accept successes so casually that often they are not even reported on the front pages of the newspapers.

In manned space flight, we have completed the Mercury and Gemini programs, which have given us 2,000 man-hours in space. This is about as much time as the average man spends on his job in a year.

We have learned to control missions and to operate manned spacecraft traveling in orbit at speeds of almost 18,000 miles an hour. Such a speed is fast enough to travel from Chicago to New York in three minutes. During these missions traveling at this speed we have had to make instant decisions whether to continue or terminate a flight -- and where to land in cases of emergency and adverse weather conditions.

We have learned that man is able to live and work effectively in weightless space flight for periods up to fourteen days.

We have learned to rendezvous a manned spacecraft with another unmanned spacecraft.

We have learned to assemble these separate craft into a spacecraft cluster.

We have learned to employ such a clustered spacecraft to launch from one orbit to another orbit, thus enabling men to fly higher and faster than they have ever flown before.

We have learned some of the problems and promise of manned activity outside a spacecraft in a protective suit. This knowledge was gained through more than 12 man-hours -- half a day -- of experience in open space.

We have learned to make precision landings of manned spacecraft, within sight of the recovery ships.

We have learned that man can perform experiments in space. These have included such carefully timed actions as photographing an eclipse of the sun.

Finally, we have learned to manage and schedule such a program, following principles that permit us either to move forward rapidly to capitalize on progress or to accommodate unexpected setbacks.

The understanding we have gained from Mercury and Gemini is being applied to the Apollo program, the largest research and development effort ever undertaken by the free enterprise system. The objective of Apollo is leadership in space. We are working to demonstrate that leadership by landing men on the moon and returning them safely to earth before this decade is out.

As we near the end of the sixth year of an uphill struggle in the Apollo program, we have in hand almost all of the elements required for its success. We have successfully completed one important series of flight tests.

The Apollo program suffered a serious setback last January in the tragic loss of three astronauts. We are taking steps to prevent a recurrence of such an accident. Both the program organization and the spacecraft design and testing program are being reviewed to deal as necessary with the hazard of fire.

The Apollo problems are large. But so is the scope of the effort to solve them. Despite these problems I for one believe we <u>can</u> achieve the mission objective of manned lunar flight and safe return in this decade.

Time does not permit me to recount all of the achievements of the space program. But there are a few of particular significance that I do wish to mention.

We have been exploring the moon in three programs in advance of our manned flights. The Ranger program supplied more than 20,000 photographs of three separate areas. In the Surveyor program two spacecraft have made soft landings on the moon. The most recent of these flights was just last week. The Surveyor flights have demonstrated that the strength of the surface at these two locations is sufficient to support the landing of an Apollo lunar module. The Lunar Orbiter program is supplying photographs that indicate the topography in several locations is suitable for landings.

Our programs have also achieved good results in the initial unmanned flights past the two nearest planets, Venus and Mars. The Mariner II flight of 1962 gave indications of high temperatures on the surface of Venus. The Mariner IV flight of 1964 and 1965 transmitted to earth pictures of Mars that made possible a preliminary understanding of conditions on that planet.

These results lead to more advanced efforts in planetary exploration. The Saturn V lunar rocket can be used to send an unmanned spacecraft, called Voyager, to the surface of Mars, where it can search for life. Such a device can be landed on Mars much like the Surveyor spacecraft was landed on the moon last week.

Now I would like to turn to the investment in the space program. We have established a nationwide complex of installations. Sixteen major prime contractors* and 20,000 subcontractors and vendors in every part of the United States support the work at these installations. The effort comprises about 400,000 people.

*Awards of $40 million or more during fiscal year 1966. More than 90 percent are employed by private industry.

The cost of this investment has passed its peak. That was in the fiscal year that ended June 30, 1966. This was 0.83 percent of the gross national product. During the current fiscal year it is estimated that the percentage will be down to 0.73. In the budget proposed for next year it would decline further, to about 0.66. Incidentally, the Soviets at this time are devoting about the same amount of effort as we on their space program. Theirs is a much greater proportion of their gross national product. And we see no sign of the Soviet effort tapering off.

Now what returns have come from the United States investment? Probably the most important return has been national growth. Altogether, the total national program of research and development has had a tremendous impact on the national economy. It is no coincidence that the surging growth of the last six years occurred at a time when the nation was investing at an unprecedented rate in R&D. I was interested to read an article on our economic growth in the March 1967 issue of Fortune magazine. The writer expresses concern whether expansion will continue at this rate in the next few years. It would seem to me that one step we can take to sustain this growth is to continue substantial investment in knowledge.

Some of the returns from the investment ~~are quite specific~~. But it is important to keep in mind the long lead time between discovery and commercial utilization. This is decreasing. For example, the origin of the computer can be traced to the abacus, invented in the earliest days of Chinese civilization. Yet it was not until 1642 that Blaise Pascal made a gear-driven computer that would add and subtract. In 1822 Charles Babbage designed a semi-automatic machine that would calculate functions, and he suggested the used of punched cards to feed data to computers. And it was in 1937 that Howard Aiken began designing a computer that had a memory and could store numbers. So this innovation took 300 years to complete.

Today our industry and government have shortened this process to the point where a new product may reach the market less than a decade after discovery.

Even on this shortened scale, of course, the bulk of the new knowledge and technology that have come out of the space program since 1958 will not yet have reached our everyday lives. Nevertheless, there already are a number of examples of such transfer.

The Comsat Corporation is in business using satellites to carry television, voice and data from one continent to another. This is already affecting the convenience and cost of international communications. For instance, Western Union International reduced trans-Pacific cable rates by 30 percent this January as a result of the economics of using communications satellites.

Observations from space are being used by the world's weather services on a routine basis. The forecast you saw in the morning paper was based in part on these observations. Computers, microminiaturized electronic systems, and tiny tape recorders are prevalent in industry and government. And they are improving at a rapid rate.

Industry is beginning to employ some of the new processes, new materials and new techniques that have emerged from space research and technology. These include high-speed metal-working, solid lubricants, and adhesives, sealants, gaskets, and better-quality paints.

In medicine, we have seen many benefits that result from the space program. The tiny bio-sensors used to monitor the astronauts' physical condition during flight are now being used in hospitals. Perhaps the most

significant contribution to medical knowledge has been the results of the extensive study of the well human being under physical and psychological stress. Doctors and medical researchers do almost all of their work with sick people. Now we have a substantial amount of baseline information on people who are healthy -- very healthy indeed. My medical colleagues tell me this is highly significant.

There has also been a definite impact on our educational system. Ever since Sputnik, the public has been quite concerned about education. Because of this concern, we have seen substantial increases in spport at the national, state and local levels, as well as by the private foundations. Those agencies of the Federal government that are heavy consumers of highly trained people have taken steps to replenish the supplies by supporting graduate education. NASA, for example, has sponsored a program that supports more than 3,600 students working toward their Ph.D.'s.

Finally, the systems analysis techniques employed in the defense, space and atomic energy programs are being adapted to the solution of other national problems. The State of California some time ago completed studies of its application to such matters as urban transportation, air and water pollution, waste disposal, and paperwork and data management.

Elsewhere, serious attention is being given to employing such techniques in programs for the desalinization of water, water resources management, urban planning and development, and high-speed transportation systems, such as the forthcoming rail link between Washington, D.C. and Boston.

Recently, I learned about a very interesting application of systems analysis. With the assistance of the United States AID mission in New Delhi the Indian state of Bihar has programmed all of the significant factors relating to famine in that country. Through a system that reports key indicators the state government has established an early warning system that flashes danger signals about impending famine soon enough to do something about it.

Again let me emphasize that these are just the first returns from this major national investment in science and technology. Much more is yet to come.

Now what investment opportunities are presented by the space program at this time? An important consideration to keep in mind is the long lead time associated with space vehicles. For example, the bulk of the work has been completed in the development and production of the Apollo-Saturn V. This is the vehicle to be employed in the manned lunar flights. Yet the first vehicle is yet to be flown. It is scheduled for later this year. Nevertheless, the total manpower in the manned space flight effort has already declined by about 20 percent from its peak of 300,000 a year ago.

Thus if we wish to make effective use of the skills and capabilities that were created over a decade, we need to act now to assure that these teams will not be dispersed.

Despite the burden of the war in Southeast Asia, the President has proposed to Congress that we begin a modest program of new undertakings. This program has only limited objectives at the present time. It is designed to return substantial dividends in relation to the cost. We want to make the most effective use of the people, industrial team, physical plant, and space vehicles that have been assembled and developed over the last decade. By doing so we hope to keep the option open to begin new programs at a later time.

As an example of how these assets will be utilized, let me briefly descrive our plans.

In the Apollo program, we are producing two major launch vehicles, the Apollo spacecraft and supporting equipment for use on earth. The launch vehicles are the uprated Saturn I for earth-orbital flights and the Saturn V for the lunar flights. We have arranged for the production and flight of a sufficient number of vehicles to achieve the Apollo lunar landing objective.

It is possible that the lunar mission may be accomplished with fewer vehicles than now scheduled. For this reason, we are beginning a program of alternate and follow-on missions, which will employ these vehicles in earth orbit and further exploration of the moon when they become available. Thus we will be keeping the team together and holding our options open for the future. Two such follow-on missions have been defined in this new program, which is called Apollo Applications.

The Apollo Applications program has four immediate objectives. The first is to reduce the unit cost operating in space. To accomplish this, we plan to experiment with several major innovations. One is to obtain double use of a rocket stage -- first to boost the spacecraft into orbit and later to use the empty rocket stage as a workshop and living space for astronauts on long flights.

Another innovation will be to use this orbital workshop repeatedly. The astronauts will return to earth in the Apollo spacecraft at the end of a mission; the workshop will remain in orbital storage until the next mission.

A third innovation will be flights of increasing duration. The greater part of the cost of space flight is for takeoffs and landings. Thus it would appear that we could obtain greater value per dollar from longer flights. However, we must study in an orderly manner the medical and psychological effects of prolonged weightless flight and the problems of maintaining suitable conditions for living and working in such confined space. For this reason, the first flight in the orbital workshop will be limited to four weeks, twice the length of the longest in Gemini. If that goes well, we will then proceed to a flight lasting up to eight weeks. Eventually, we hope to extend the duration to a year or more in orbit.

The second objective of Apollo Applications is astronomical observation in space. On earth, astronomers are limited by the fact that our atmosphere absorbs a large proportion of the radiance of the sun and the stars. Thus the light that does reach us is distorted and diminished; the stars dance and twinkle. There being no way to bring this light to the astronomer on earth, we plan to experiment with bringing him and his telescope where the action is -- above the atmosphere. On the second Apollo Applications mission, we will attach a telescope mount to a modified Apollo spacecraft. On this mount we will install a group of telescopes designed to observe the sun during the peak of the 11-year sunspot cycle, about two years from now. This will make it possible to learn much more about the sun and its relationship to weather on earth.

The third objective of the Apollo Applications program is to study how man in space can be of direct benefit to man here on earth. For example, as we look towards the future, we can see the prospect of a comprehensive system of meteorological satellites that could work with hundreds of automatic and semi-automatic ground stations. The resulting improvement in short and long-range weather forecasts would be worth billions of dollars to farmers, fuel producers, public utilities, construction industries and water managers -- to say nothing of the convenience for ordinary citizens planning vacations and other free time. Such a system would also enable us to detect natural phenomena such as volcanic eruptions, soil erosion, landslides, icebergs, and forest fires.

One of the most interesting of the earthly applications of space flight is the observation and study of the earth's resources. Surveillance of crops, for example, could provide a daily record of the changes during the growing seasons. Ocean monitoring could keep track of such things as the sea state, ice movements, water temperature, and salinity. By tracing the movement of plankton, it could tell the whereabouts of large schools of fish. Photographs and other observations made in the Gemini program have already shown a tremendous potential here. I would not be surprised if the time should come when the benefits from earth observations alone fully justify the entire cost of this program.

Satellite observations could also be employed to increase the efficiency of transportation, particularly the operation of ships and aircraft through navigation and traffic control. Still others, many of these privately owned, could provide a system of world-wide home-to-home communications and direct-broadcast television.

The last of the early objectives of Apollo Applications is to learn more about the moon after the first astronauts complete their missions, bringing back samples of the moon and leaving a package of experiments to operate after their return to earth.

On the first missions, the astronauts will be limited to a maximum of 36 hours of stay-time on the lunar surface, and to a distance of about 1,000 feet from the spacecraft. The follow-on Apollo Applications flights are expected to progressively lengthen this stay period to about two weeks. Development of simple roving vehicles will increase their travel capabilities to 10 or 15 miles from the lunar station.

People sometimes ask me why we should explore the moon. I suppose I must go back to President Eisenhower's statement.

citing the compelling urge of man to explore and to discover. The principal reason is that we do not know what we will find. The moon has a land area as big as Africa. It just seems inconceivable to me that we would stop after one or two visits limited to the area a few miles from the landing point.

As stated earlier, this program has limited objectives. But the President's action in proposing it to the Congress does represent a major decision. It is a decision to continue beyond the Apollo program the utiliziation of the assets in people, industrial team, physical plants and flight vehicles created in painstaking fashion over the last decade.

This approach will maintain the orderly pace of our progress. It will reduce the possibility of a new Soviet "surprise," which could lengthen their lead ahead of us in space.

It will sustain the forward momentum of technological advance that has helped the competitive position of our industy in the world market place.

It will continue the flow of new products, new processes and new ideas that have nourished our growing economy.

It will support the broad base of science and technology vital to our security as a nation.

It will return increased benefits to man on earth.

It will avoid the wasteful dissipation of our space capability.

And finally, it will enable us to continue the exploration of space, an exploration that holds untold promise for all mankind.

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